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OSAGE - GASCONADE BASIN

D & R PIPELINE CONSTRUCTION COMPANY LAKE
GREENE COUNTY, MISSOURI
MO 20396

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PHASE 1 INSPECTION REPORT

(b) NATIONAL DAM SAFETY INSPECTION

D and R Pipeline Construction Company Lake
(MO 20396). Osage - Gasconade Basin,
Greene County, Missouri. Phase I Inspection
Report.

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United States Army
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St. Louis District

9) Final rept.,

15 DACW43-79-C-0070

10 John M. /Healy Steven L. /Brady
Nelson /Morales Tom /Beckley

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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7. AUTHOR(s) Anderson Engineering, Inc.		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		8. CONTRACT OR GRANT NUMBER(s) DACW43-79-C-0070
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: D & R Pipeline Construction Company Lake Dam Phase
I Inspection Report

This report presents the results of field inspection and evaluation of the D & R Pipeline Construction Company Lake Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood.
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY:

SIGNED
Chief, Engineering Division

31 AUG 1979

Date

APPROVED BY:

SIGNED
Colonel, CE, District Engineer

31 AUG 1979

Date

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D & R PIPELINE CONSTRUCTION COMPANY LAKE

GREENE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20396

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by

Anderson Engineering, Inc. Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction of

St. Louis District, Corps of Engineers

For

Governor of Missouri

August, 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam:	D & R Pipeline Construction Company Lake
State Located:	Missouri
County Located:	Greene County
Stream:	Tributary of Little Sac River
Date of Inspection:	15 May 1979

D & R Pipeline Construction Company Lake was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam has been classified by the St. Louis District Corps of Engineers as a small size dam with a high downstream hazard potential. The estimated damage zone extends approximately 2.0 miles downstream of the dam. Within this damage zone are 4 dwellings.

Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 31 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the small volume of

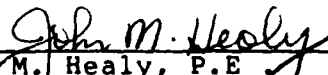
water impounded, and the height of the dam, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The 100-year frequency flood will not overtop the dam. The 100-year flood is one that has a 1 percent chance of being exceeded in any given year.

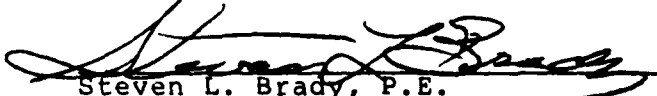
The embankment appeared to be generally in good condition. Deficiencies visually observed by the inspection team were: (1) the emergency spillway has eroded badly and will completely erode with continued use; the spillway needs immediate repair; (2) the primary 36 inch spillway pipe is plugged with debris; (3) the discharge channel is tree and brush covered; (4) some brush and tree growth on the downstream face; and (5) an area of standing water at the toe of the embankment that should be investigated further to determine if it is due to seepage.

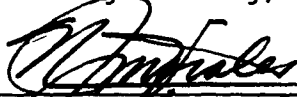
The St. Louis District Corps of Engineers was notified of the emergency spillway erosion condition and a subsequent inspection was performed by a geologist of the Department of Natural Resources.


Another deficiency was the lack of seepage and stability analysis records.

It is recommended that the owners take the necessary action in the very near future to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.


John M. Healy, P.E.
Hanson Engineers, Inc.


Steven L. Brady, P.E.
Anderson Engineering, Inc.


Nelson Morales, P.E.
Hanson Engineers, Inc.


Tom Beckley, P.E.
Anderson Engineering, Inc.



OVERVIEW OF DAM AND LAKE

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

D & R PIPELINE CONSTRUCTION COMPANY LAKE - ID No. 20396

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of D & R Pipeline Construction Company Lake Dam in Greene County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

D & R Pipeline Construction Company Lake Dam is an earth fill structure approximately 23 ft. high and 450 ft. long at the crest. The appurtenant works consist of a primary spillway near the west abutment and an emergency spillway in the east abutment. The primary spillway inlet consists of a 36 inch diameter drop inlet pipe with a 24 inch outlet pipe. An 8 inch diameter pipe operated by a gate valve is located at the bottom of the primary spillway for draining the lake. Sheet 3 of Appendix A shows a plan profile and typical section of the embankment.

B. Location:

The dam is located in the northeast part of Greene County, Missouri on a tributary of the Little Sac River. The dam and lake are within the Bassville, Missouri 7.5 minute quadrangle sheet (Section 14, T36N, R21W - latitude 37°19.3'; longitude 93°12.5'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 23 ft. and a maximum storage capacity of approximately 102 acre-ft., the dam is in the small size category because the storage capacity is greater than 50 acre feet.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends approximately 2.0 miles downstream of the dam. Within the damage zone are four dwellings.

E. Ownership:

The dam is owned by D & R Pipeline Construction Company. The owners address is 2823 Imperial Circle, Springfield, Missouri, 65804. (Telephone number is 417-883-1439.) The local contact is Mr. Darrel Lawson at the same address.

F. Purpose of the Dam:

The dam was constructed primarily for watering cattle and erosion control.

G. Design and Construction History:

The dam was designed by the United States Department of Agriculture, Soil Conservation Service. Design plans and notes were obtained from the SCS office and are included in Appendix A. The dam was constructed by the past owner, E.H. Green, of Springfield, Missouri, (telephone 417-833-2500), and completed in 1975. The material for the dam was taken from the lake area. The past owner stated that erosion of the emergency spillway had to be repaired. The past owner also indicated that the only modification made during the

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original construction was changing the valve for draining the lake from a slide to a gate valve.

H. Normal Operative Procedures:

Normal flows are to be passed by the 36 inch primary spillway with excess flow passed by the emergency spillway on the east abutment. The previous owners did not know the maximum water level the dam had attained.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 560 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through uncontrolled spillways. Rating curves were developed assuming a combination of Weir and pipe flow for the principal spillway and critical flow for the emergency spillway section.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 56.1: 1501 cfs)
- (3) Estimated Capacity of Primary Spillway: 69 cfs
- (4) Estimated Experienced Maximum Flood at Dam Site: Unknown
- (5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (7) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations: (Benchmark = 49.50, Elevation at primary spillway crest)

- (1) Top of Dam (Measured): West end 57.5; middle 57.0; east end 56.1. Top of dam (plan for construction) 56.4
- (2) Principal Spillway Crest: Plans for construction 49.5 (Benchmark of 49.5 for all other measurements)
- (3) Emergency Spillway Crest: Plans for construction 51.5, measured 49.9.
- (4) Principal Outlet Pipe Invert: Plans for construction 37.5, not measured in field because of debris.
- (5) Streambed at Centerline of Dam: Plans for construction 35.0, measured water surface in plunge pool 35.0.
- (6) Pool on Date of Inspection: measured 49.65.
- (7) Maximum Tailwater: Unknown
- (8) Upstream Portal Invert Diversion Tunnel: Not Applicable
- (9) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

- (1) At Top of Dam: 2300 Feet
- (2) At Principal Spillway Crest: 1800 Feet
- (3) At Emergency Spillway Crest: 1840 Feet

E. Storage Capacities:

- (1) At Principal Spillway Crest: 34 Acre-Feet
- (2) At Top of Dam: 102 Acre-Feet
- (3) At Emergency Spillway Crest: 38 Acre-Feet

F. Reservoir Surface Areas:

- (1) At Principal Spillway Crest: 7 Acres

- (2) At Top of Dam: 14 Acres
- (3) At Emergency Spillway Crest: 7.5 Acres

G. Dam:

- (1) Type: Rolled earth
- (2) Length at Crest: 450 Feet
- (3) Height: 23 Feet
- (4) Top Width: 15 Feet
- (5) Side Slopes: Upstream 2.5:1; Downstream 2.0:1 & 3.2:1
- (6) Zoning: Homogeneous
- (7) Impervious Core: Unknown
- (8) Cutoff: Unknown
- (9) Grout Curtain: Unknown

H. Diversion and Regulating Tunnel:

- (1) Type: None
- (2) Length: None
- (3) Closure: None
- (4) Access: None
- (5) Regulating Facilities: None

I. Spillway:

I.1 Principal Spillway:

- (1) Location: West end of dam at Sta. 0 + 76.
- (2) Type: 36 inch CMP drop inlet pipe with a 24 inch CMP through the embankment.

I.2 Emergency Spillway:

- (1) Location: East abutment

(2) Type: Earth Channel

J. Regulating Outlets:

An 8 inch diameter Hel-Cor Coated CMP and gate valve is located under the dam at Sta. 0 + 76 for drawdown purposes. The 8 inch pipe drains into the 36 inch primary spillway riser. See Sheet 4 of Appendix A.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

Design notes and a design cross section of the embankment are available from the Dept. of Agriculture Soil Conservation Service Office at 3003 E. Trafficway, Springfield, Missouri. Copies of these design notes are included in Appendix A and hydraulic calculations are included in Appendix C as Sheets 10 and 11. No documentation of construction inspection records have been obtained. There are no documented maintenance and operation data to our knowledge.

A. Surveys:

No information regarding pre-construction surveys was able to be obtained. The top edge of the 36 inch primary spillway was used as datum for our site survey (Elevation 49.5 as shown on the SCS design sheet, Sheet 4 of Appendix A.)

B. Geology and Subsurface Materials:

The topography around the site is gently rolling to hilly. This area is at the eastern edge the Western Plains region of the state. Generally the soils around the dam site consist of deep, well drained, cherty silty clay soils. Those soils are residual from cherty Mississippian limestones. Typically these soils have a brown cherty clayey silt surface layer followed by a reddish brown friable silty clay containing considerable chert rock fragments. The lower horizon is a red, dark red crumbly, plastic silty clay which has varying amounts of chert rock. Weathered ledge rock is often found near the surface in this area. The underlying rock is of the Burlington formation of the Osagean Series of the Mississippian Systems. The Burlington formation is a white to light buff, very coarsely crystalline, fossiliferous, crinoidal limestone. Layers of chert nodules are common in the upper portions of this formation. This bedrock has often weathered unevenly leaving pinnacles, mushroom-like knobs projecting from the rock surface. The crevices between these knobs are filled with the red, often highly plastic, silty clay.

Geologic mapping of Greene County, Missouri, compiled by Kenneth C. Thomson of Southwest Missouri State University, shows one fault zone near this site. The Strafford

fault lies approximately 2 miles to the south of the dam site. The Department of Natural Resources has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years (rock associated with the Mississippian period is approximately 300 million years old). Additional mapping by Mr. Thomson indicates the nearest area of sinkhole features is approximately 2 miles south of the dam site. The nearest cave is approximately 1 1/2 miles west of the dam site. These features are shown on Sheets 3 and 4 of Appendix B.

C. Foundation and Embankment Design:

The Soil Conservation Service designed an embankment cross section which is shown on Sheet 4 of Appendix A. No other foundation or embankment design information was available. Information from the past owner, E. H. Green, indicates that the dam was constructed from the silty clay soils from the lake area. There is apparently no particular zoning of the embankment and no internal drainage features are known to exist. No construction inspection test results are available.

D. Hydrology and Hydraulics:

The original hydraulic and hydrologic design data has been obtained from the Soil Conservation Service and are presented on Sheets 10 and 11 of Appendix C. Based on a field check of spillway dimensions, embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analysis using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix C, Sheets 1 thru 9. It was concluded that the structure will pass 31 percent of the Probable Maximum Flood without overtopping the dam as the emergency spillway now exists at elevation 49.9. However, if the spillway is repaired and the crest set at the SCS design elevation of 51.5, the structure will only pass 24 percent of the PMF and will probably not pass the 100-year frequency flood. The summary of Dam Safety Analysis for this condition is presented on Sheets 8 & 9 of Appendix C. It was concluded that the structure will pass 31 percent of the Probable Maximum Flood without overtopping. The 100-year frequency flood will not overtop the dam.

E. Structure:

There are no appurtenant structures, other than the drawdown pipe and primary spillway, associated with the dam.

The 24 inch diameter outlet pipe for the primary spillway apparently has three anti-seep collars as shown on Sheet 4 of Appendix A.

2.2 CONSTRUCTION:

No construction inspection data have been obtained. Some cross-sections apparently taken after construction was completed were located in the SCS file. This data is included in Appendix A on Sheets 8 through 11.

2.3 OPERATION AND MAINTENANCE:

No operation and maintenance records were available. Inspection indicates that maintenance of the dam (mowing the grass and brush removal) is done periodically. Small amounts of brush are starting to grow on the downstream face. Maintenance of the emergency spillway has not been performed for quite some time.

2.4 EVALUATION:

A. Availability:

The engineering data available are as listed in Section 2.1.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

The design sheets prepared by the Soil Conservation Service and included in Appendices A and C are valid engineering data on the design of the dam.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General:

The field inspection was made on 15 May 1979. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Tom Beckley P.E.- Anderson Engineering, Inc. (Civil Engineer)
Steve Brady P.E.- Anderson Engineering, Inc. (Civil Engineer)
Jack Healy P.E.-Hanson Engineers, Inc. (Geotechnical Engineer)
Nelson Morales P.E.- Hanson Engineers, Inc. (Hydrologic and Hydraulic Engineer)

B. Dam:

The embankment of the dam appears to be in generally good condition. No sloughing or obvious seepage through the embankment was noted. The dam was constructed with a gentle curve which is concave to the downstream direction. The dam is fairly level across the crest, and no surface cracking or unusual movement was obvious. Shallow auger probes into the embankment indicated the top portion of the embankment to consist of reddish-brown residual silty clay with chert rock fragments. The downstream face of the right abutment was quite steep however there is very little drainage on it and therefore no erosion at this time. There was no noticeable serious erosion on the embankment, with exception of the east abutment at the emergency spillway, which will be discussed in subparagraph D.

The embankment is grass-covered and appears to be mowed occasionally. A small amount of brush is starting to grow on the downstream face and some small trees are present on the embankment near the 24 inch spillway outlet.

No animal burrows were detected although some could exist in the areas of heavier brush and grass. No riprap exists on the front face of the embankment and no serious erosion appears to have occurred.

A wet area existed at the toe of the embankment approximately 150 feet left of the primary spillway outlet. The water is approximately 1 foot deep. No movement of the water

or boils were detected. This area could be as a result of discharge from the emergency spillway or ground water level. It is also possible that some leakage could be occurring under the dam.

No instrumentation (monuments, piezometers, etc.) was observed.

C. Appurtenant Structures:

C.1 Primary Spillway and Outlet:

The primary spillway consists of a 36 inch vertical CMP riser at the front face of the embankment near the west abutment. The lower portion of the riser pipe was plugged with logs and debris. The logs pass through a steel bar trash rack that sits on top of the spillway riser. The approach to the spillway is generally clear however there is some debris around the trash rack. The 24 inch outlet pipe is in good condition and assumed to be partially blocked since only a small amount of water was coming out of this pipe at the time of inspection even though there was approximately 3 feet of water standing inside the riser. The outlet pipe entrance must be partially blocked. No seepage was noted around the outside of the primary spillway pipe near the outlet end.

A valve handle extends out of the 36 inch riser pipe. Sheet 4 of Appendix A shows an 8 inch drawdown pipe that ties into the 36 inch CMP riser. Mr. E. H. Green, the prior owner, indicated the handle operates a gate valve on the 8 inch drawdown pipe.

The SCS design sheet (Sheet 4 of Appendix A) also shows three antiseep collars around the 24 inch outlet pipe.

C.2 Emergency Spillway:

The emergency spillway located at the east abutment has been very seriously eroded by flows through the spillway. The SCS design sheet (Sheet 4 of Appendix A) shows an elevation difference of 2 feet between the primary and emergency spillways. At the time of our inspection the emergency spillway had eroded to the point that there was only a 4 inch difference in the elevation of the emergency spillway crest and the primary spillway overflow. The emergency spillway will severely erode with continued use. The fact that the primary spillway is almost completely plugged means

that the emergency spillway will be used during any rainfall event sufficient to raise the lake level 4 inches.

D. Reservoir:

The watershed is a combination of wooded area and pastureland. Its slopes adjacent to the lake are moderate and no sloughing or serious erosion was noted. There does not appear to be a problem with siltation.

E. Downstream Channel:

The discharge channel is covered with trees and brush starting 50 feet downstream.

3.2 EVALUATION:

The emergency spillway should be repaired. Continued use of the spillway will cause it to severely erode. The primary spillway riser should be cleared of logs and debris and the trash rack modified to keep logs and trash from entering the drop inlet pipe. Trees and brush on the downstream face near the 24 inch outlet pipe should be cleared and the rest of the embankment cleared on an annual basis. Removal of large trees should be under the guidance of a professional engineer experienced in the design and construction of earthen dams. The wet area (possibly underseepage) at the downstream toe should be investigated by an engineer experienced in the design and construction of dams.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no controlled outlet works for this dam, except for the 8 inch drawdown pipe, which is operational but apparently used very infrequently. The spillway is uncontrolled so that the pool is normally affected by rainfall, runoff, evaporation, seepage, and the capacities of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM:

The grass cover on the embankment appears to be mowed yearly. According to Mr. E. H. Green, the prior owner, the emergency spillway was repaired once after it had eroded badly.

4.3 MAINTENANCE OF OPERATING FACILITIES:

Although the drawdown facilities appear to be in good condition, it is not known whether they are regularly maintained.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

Tree and brush growth should be removed from the dam as they develop on a yearly basis. Removal of large trees should be under the guidance of a professional engineer experienced in the design and construction of earthen embankments. Erosion of the embankment at the emergency spillway should be controlled. The rack on top of the primary spillway should be cleared of debris on a regular basis.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. & B. Design and Experience Data:

The hydraulic and hydrologic analyses were based on: (1) a field check of spillway dimensions and embankment elevations; and (2) a check of the pool and drainage areas from the U.S.G.S. quad sheet; and (3) hydrologic design sheets by the SCS. The hydrologic and hydraulic analyses using U.S. Army Corps of Engineers guidelines appears in Appendix C.

C. Visual Observations:

The 36 inch drop inlet pipe should be cleared of logs and debris and the trash rack should be modified to keep logs and debris out of the pipe. The emergency spillway has eroded badly and should be repaired before it erodes completely. The downstream channel of the primary spillway should be cleared of tree and brush growth. The emergency spillway channel is away from the dam and spillway releases would not be expected to endanger the dam.

D. Overtopping Potential:

Based on the hydrologic and hydraulic analysis presented in Appendix C, the combined spillways will pass 31 percent of the Probable Maximum Flood at the present emergency spillway elevation. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the small volume of water impounded, and the height of the dam, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The structure will pass a 100-year frequency flood without overtopping.

The routing of 50 percent of the PMF through the spillways and dam indicate that the dam will be overtopped by 0.89 ft. at elevation 56.99. The duration of the overtopping will be 0.92 hours and the maximum outflow will be 3136 cfs. The maximum discharge capacity of the spillways is 1501 cfs. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Visual observations which could adversely affect the structural stability of this dam are discussed in Section 3.1B and 3.2.

B. Design and Construction Data:

Design data obtained are included in Appendix A and Appendix C. Construction check survey notes were located in SCS files and are included in Appendix A as Sheets 8 through 11. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

To our knowledge, no post-construction changes have been made. According to Mr. E. H. Green, a prior owner, the emergency spillway was repaired once.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be corrected or controlled. These items are: (1) Clearing the plugged 36 inch drop inlet pipe, (2) Repair of the emergency spillway before it erodes completely, (3) Some brush and tree growth on the downstream face, (4) Possible seepage (water standing) area at downstream toe, and (5) Tree and brush growth in discharge channel of the primary spillway.

The dam will be overtopped by flows in excess of 31 percent of the Probabiy Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on review of the information listed in Section 2.1, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the very near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the future. Priority should be given to repairing the emergency spillway and clearing the primary spillway.

D. Necessity for Phase II:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

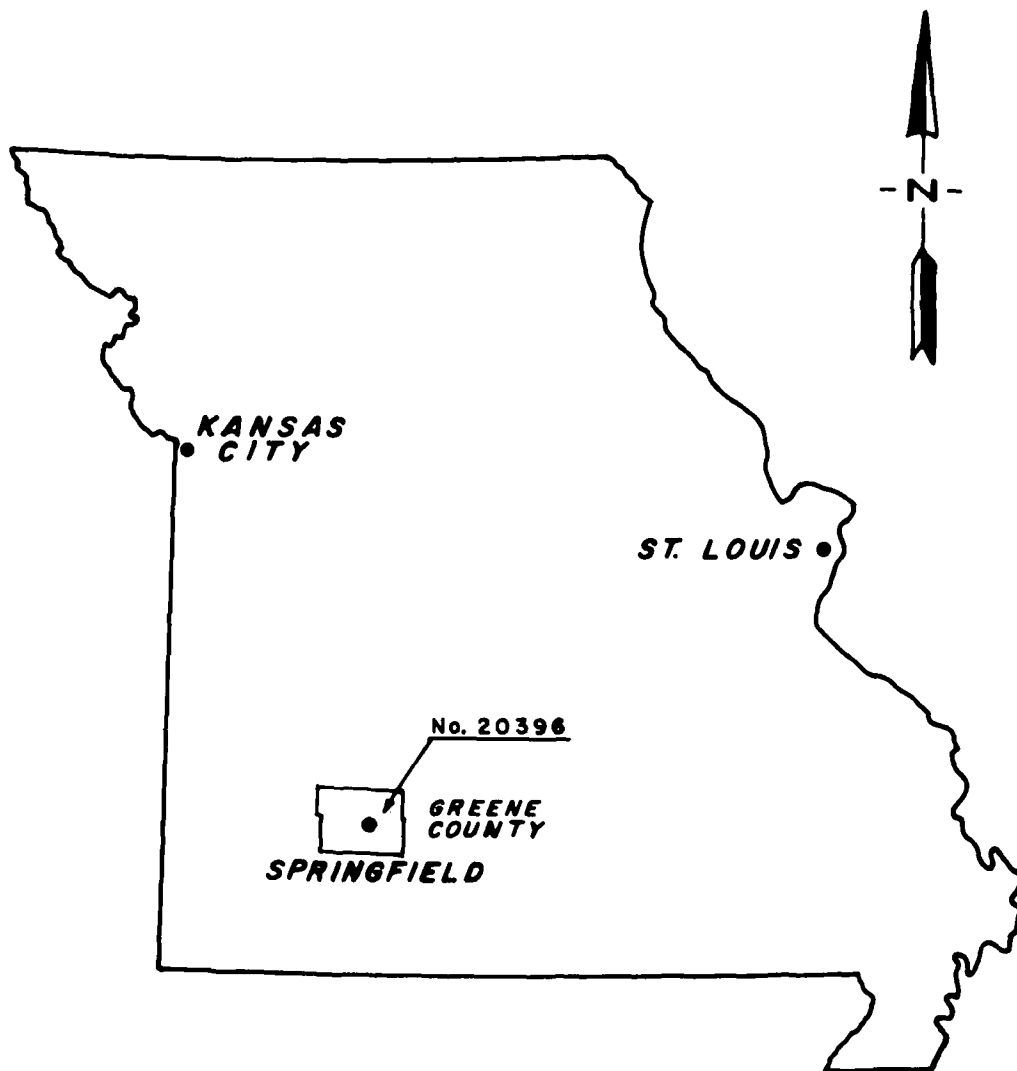
The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

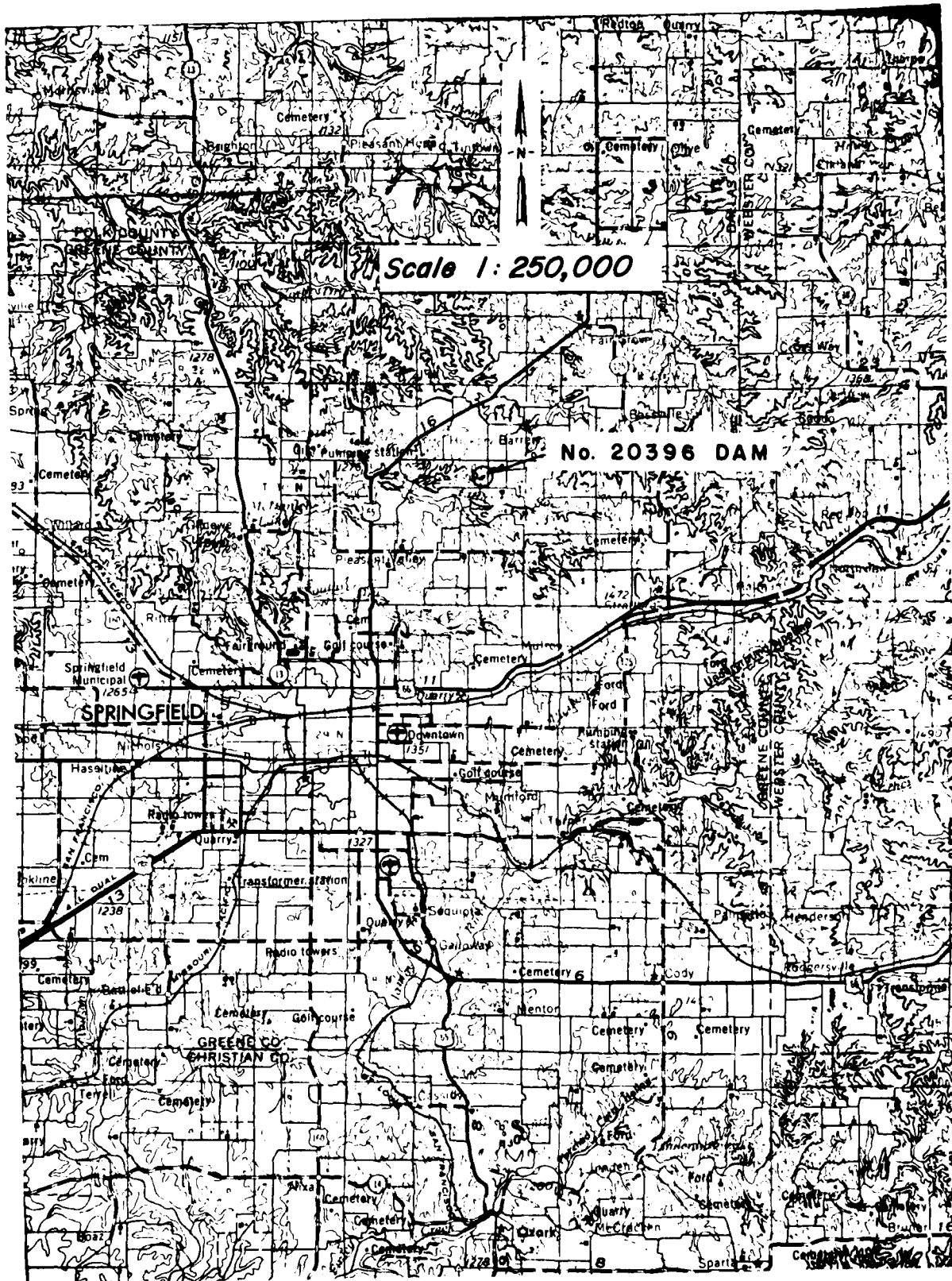
The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

- (1) The size of the emergency spillway and/or height of dam should be increased to pass 50 percent of the PMF. In either case, the spillway should be protected to prevent erosion.
- (2) The primary spillway should be cleared and the trash rack modified (by possibly adding additional vertical and horizontal bars) to keep logs and debris from entering the drop inlet pipe.
- (3) Brush and tree growth should be removed from the dam and the primary spillway outlet channel.
- (4) The possible seepage area at the downstream toe should be evaluated by a professional engineer experienced in the design and construction of dams.
- (5) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by a professional engineer experienced in the design and construction of dams.
- (6) A detailed inspection of the dam should be made periodically by a professional engineer experienced in the design and construction of dams.

APPENDIX A



LOCATION MAP



SITE VICINITY MAP

BENCHMARK:
 PRIMARY SPILLWAY PIPE
 OVERFLOW ELEV. = 49.50

TOP OF 24" SPILLWAY
 PIPE = 38.10

WATER SURFACE BELOW
 SPILLWAY PIPE = 35.80

PRIMARY SPILLWAY
 OVERFLOW 49.50

LAKE

2+00

3+00

WATER LEVEL = 49.6

+49.9

+51.3

57.0

57.0

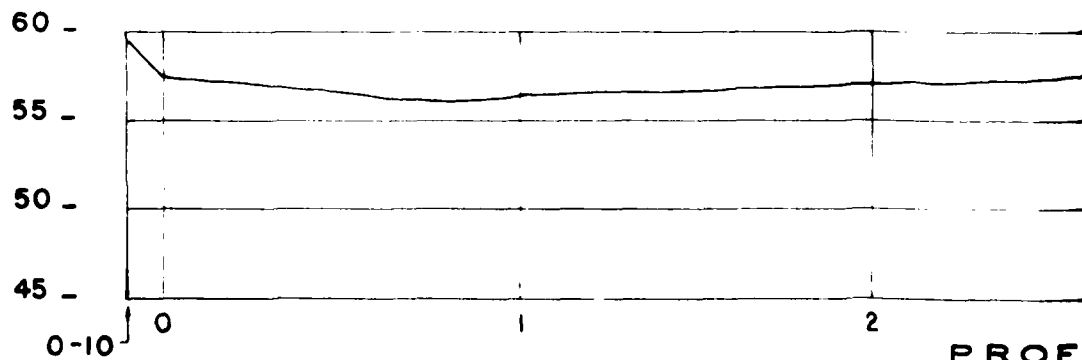
56.6

39.9

TOE OF SLOPE

PLAN VIEW

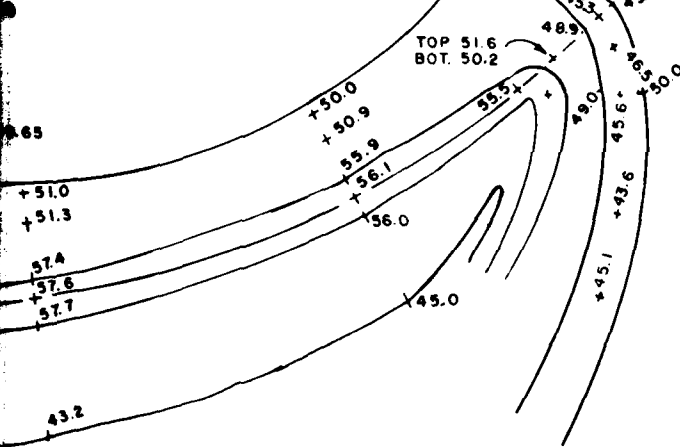
SCALE: 1" = 50'



PROF

00+4

00+9



WATER LEVEL
49.65

50

SECTION

- 60

- 55

- 50

- 45

3

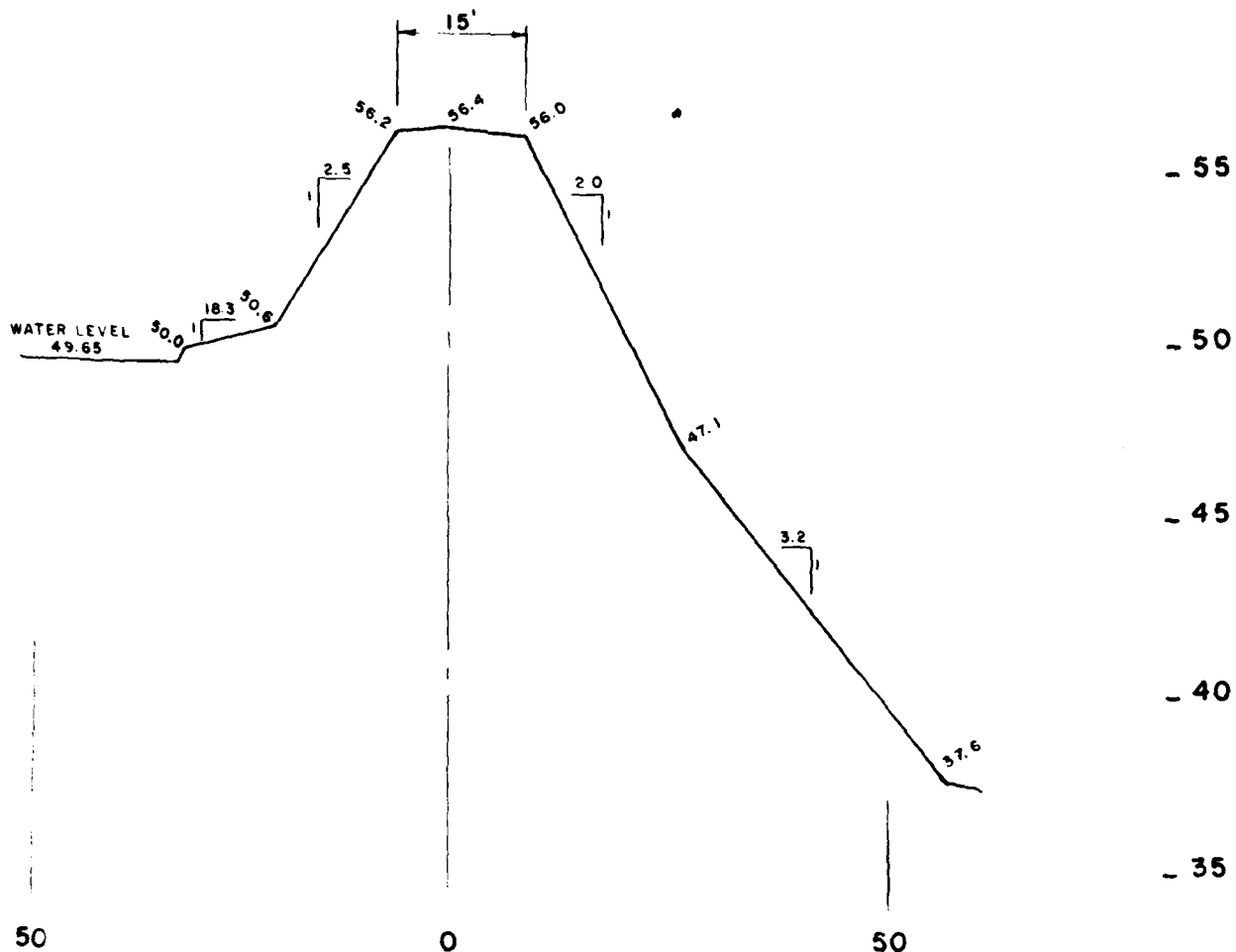
4

5

5+01

FILE

SM



SECTION A-A STA 1+00

ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

**D & R PIPELINE
CONSTRUCTION COMPANY
LAKE**

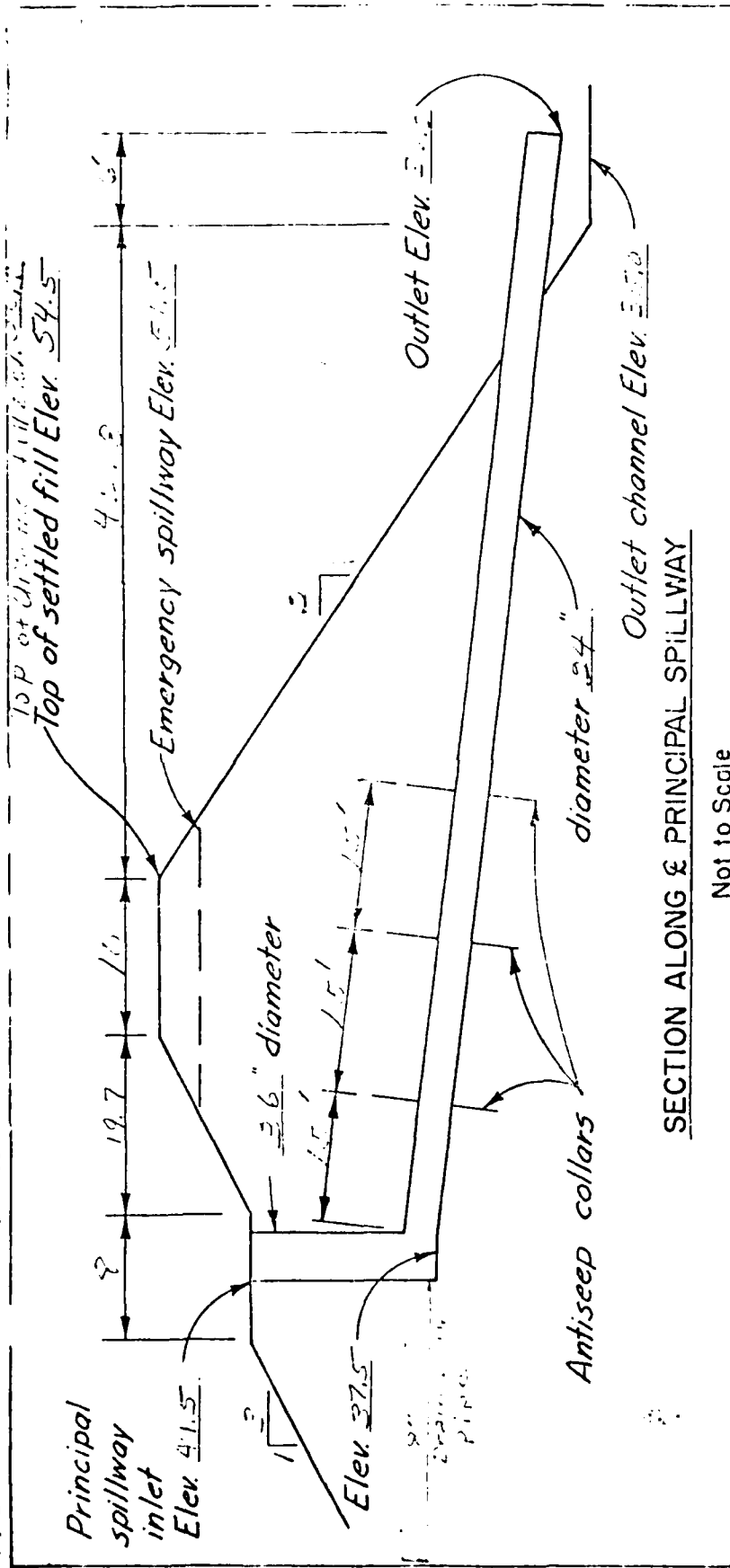
MO. No. 20396

PLAN & PROFILE

GREENE COUNTY, MO.

SHEET 3 OF APPENDIX A

3



Sheet 4 of Appendix A

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DROP INLET SPILLWAY

Landowner <u>L. J. ...</u>	County, Missouri
Designed by <u>C. L. ...</u>	Date <u>1-21-74</u>
Checked by <u>C. L. ...</u>	Date <u>1-26-74</u>
Approved by <u>C. L. ...</u>	Date <u>1-26-74</u>
Sheet <u>1</u> of <u>3</u>	

5, L-27, 950

ESTIMATED QUANTITIES

QUAN.	UNIT	ITEM
12,114	cuyds	Earth Excavation
1,000	cuyds	Core Trench Excavation
80	ft	24" Coated Pipe 14 Gage
13	ft	36" Coated Pipe
3	Nb.	60" x 60" Antiseep Collar
44	ft	8" Antiseep Collar
1	Nb.	24" Antiseep Collar
1	24" x 24"	Antiseep Collar
1	ft	Antiseep Collar

Landowner or Watershed 5000

Location or Sub-watershed

Top of Fill: Width 10 feet; Elev. 54.5. Side Slopes: Downstream 2:1; Upstream 3:1

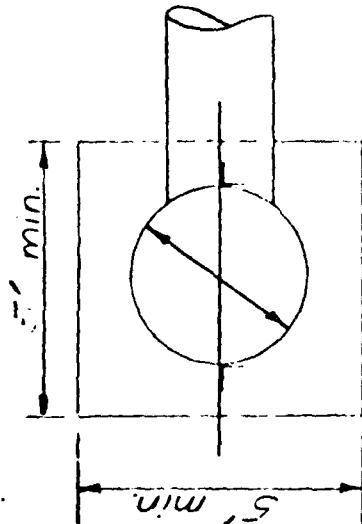
Upstream Berm: Width 8 feet; Elev. 49.5 . Downstream Berm: Width — feet; Elev. —

Computed by C. J. Johnson Date 9-25-74 Checked by C. Johnson Date 9-26-74

[illegible]

Sheet 5 of Appendix A

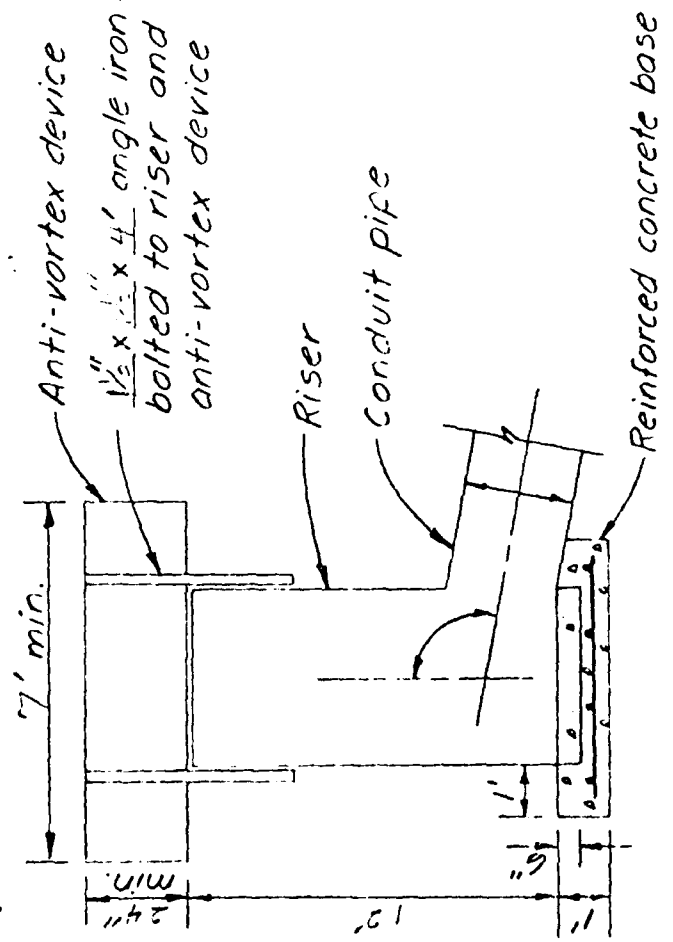
Allow _____ % for Settlement. _____
Side Spillway Fill (Including Dikes). _____
Backfill for Core Trench Excavation _____
Backfill for Structure Excavation _____
Backfill for Stripping. _____
Total Fill Quantity (Class _____) _____



Top View

Notes:

1. Weld between riser and conduit pipe shall be watertight and covered with two coats of zinc-oxide paint.
2. Reinforcing steel shall be $\frac{1}{2}$ " diameter spaced at 12" centers both ways, imbedded in a minimum of 3" of concrete.
3. Minimum pipe gage shall be 1.31
4. Anti-vortex device shall be same minimum gage as pipe.
5. Direction of corrugations shall be perpendicular to angle iron on anti vortex device.



SECTION ALONG Q OF INLET

Sheet 7 of Appendix A

Not to Scale

UNITED STATES DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	
DETAILS OF CORRUGATED METAL PIPE DROP INLET SPILLWAY	
Landowner <u>E. H. ...</u>	County, Missouri
Designed by <u>C. M. ...</u>	Date <u>...</u>
Checked by <u>C. M. ...</u>	Date <u>9-26-74</u>
Approved by <u>C. M. ...</u>	Date <u>9-26-74</u>
Sheet <u>7</u> of <u>7</u>	

Construction CK.
Green Lake

5+00	3.3	54.8	55.1	6.3	51.8	49.7	+0.8		
1+00	2.3	55.8	55.0						
+39	2.1	56.0	55.2	6.3	51.8	49.7	+0.8		
-00	1.1	57.0	55.4	5.6	52.5	50.0	+1.4		
-45	0.4	57.7	55.7	5.6	52.5	50.0	+0.0		
+25	0.9	57.2	55.8	7.0	51.1	50.3	+1.4		
+03	1.2	56.9	56.0	7.3	50.8	50.0	+0.9		
+79	1.5	56.6	56.0	7.5	50.5	50.0	+0.7		
+13	1.4	56.7	56.2	6.7	51.2	50.0	+0.5		
+32	1.5	56.6	56.0				+0.2		
+40	0.1	58.0							

7. 2

BS 9.50 4158.3-

6.9 6.12
6.8 6.17

4.3.7 5.2

2017.11.11

14: 7.2 5.2

1951

7.5 50.

TREX
RACK
NOTION

3241

5285

2.24.

10

5

6

1.

0

69.

10/12/19

2

18.0

55

2

10

2

7.

100

Sheet 9 of Appendix A

Greenforts.
check out.

0700	51.5	
122	55.2	49.5
1740	55.5	50.0
1782	55.1	50.3
2455	55.8	50.3
5044X 4732	56.1	50.9

552

0+00 - 51.5 spwy

2
2.2

47.4

Fill 2.8
2.12 2.8

9
0+22
55.2
52.7
Fill 2.2

Berm
49.5
48.4
Fill 1.2

Ber 17
49.5

1440

44.2
10.3 + 1 - 11.3 Fill

55.5
55.2
Fill 1.3

50.0
54.3
53.5
1.5 4.3

50.0
51.1
Cut 1.1

1782
55.8

50.3
53.6
Cut 3.3

2+55

41.4
13.1 + 1.3 14.4

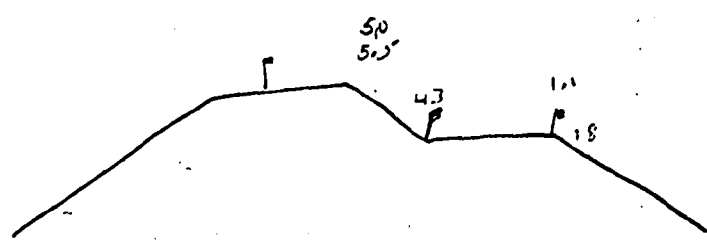
55.8
54.6
Fill 1.2

Berm
50.3
50.4
Cut 1.3

50.3
45.5
Fill 1.8

49.5
44.2
5.3

54.5
56.9
54.5
1.3
2.2



May 17, 1979

Department of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Attention: Jerry Phelan

Re: Phase I Inspection
Dam ID #20396
Greene County, Missouri

Inspection personnel from Anderson Engineering and Hanson Engineers performed a field inspection of the referenced dam on May 15, 1979.

As per our telephone conversation this day with Jerry Phelan, we believe that an imminent threat of failure exists for the referenced dam. The emergency spillway has eroded to the point that only a small bridge of soil is holding back the lake.

There is approximately four (4) inches elevation difference between the primary spillway overflow and the high point of the remaining part of the emergency spillway. Any rainfall sufficient to cause the lake level to flow over the emergency spillway could cause failure.


The primary spillway is a 36 circular CMP riser. The riser is plugged with logs and debris such that it will carry only a small percentage of its normal capability. This condition has very possibly, caused the erosion of the emergency spillway.

The owner of the dam is the D & R Pipeline Construction Company of 2823 Imperial, Springfield, Missouri 65804. The local contact is Mr. Darrel Lawson of the same address as listed above. The telephone number for Mr. Lawson is 417/883-1439.

Should you have any questions, please give us a call.

ANDERSON ENGINEERING, INC.

By:


Steven L. Brady, P.E.
Vice President

Sheet 12 of Appendix A

SLB/ck

cc: Hanson Engineers, Inc.

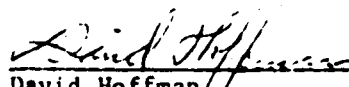
LAWSON LAKE DAM
MO 20396

NW $\frac{1}{4}$, NE $\frac{1}{4}$, NW $\frac{1}{4}$, SE $\frac{1}{4}$, Sect. 14, T30N, R21W
Bassville 7 $\frac{1}{2}$ ' Quad, Green County

On May 17, 1979, the St. Louis District, U. S. Army Corps of Engineers telephoned to report that this dam had a serious spillway erosion problem. An investigation to determine how seriously this erosion threatened the embankment was deemed necessary. Mr. Lawson was contacted and permission to revisit the site on May 18, 1979 was obtained. Steve Brady of Anderson Engineering, Inc. was also contacted and arrangements made to meet him and visit the site together.

Steve Brady and I visited the dam on the morning of May 18 and reinspected the emergency spillway. The emergency spillway is in the left abutment and is in natural ground. Erosion is working its way upstream from the lower end of the spillway toward the lake. The spillway originally was an estimated 75 feet long. Erosion has cut its way upstream to within two or three feet horizontally of the lake. The bottom of the erosion channel is 3 to 4 feet below the lake level at a point only about 20 feet from the lake. During heavy rain when the emergency spillway is used further erosion of the spillway will likely occur. The spillway is in residual soil with large rock fragments which is relatively resistant to erosion. However, if the spillway is not repaired the next large rain may be sufficient to erode the spillway bottom upstream into the lake and thereby lower the lake level.

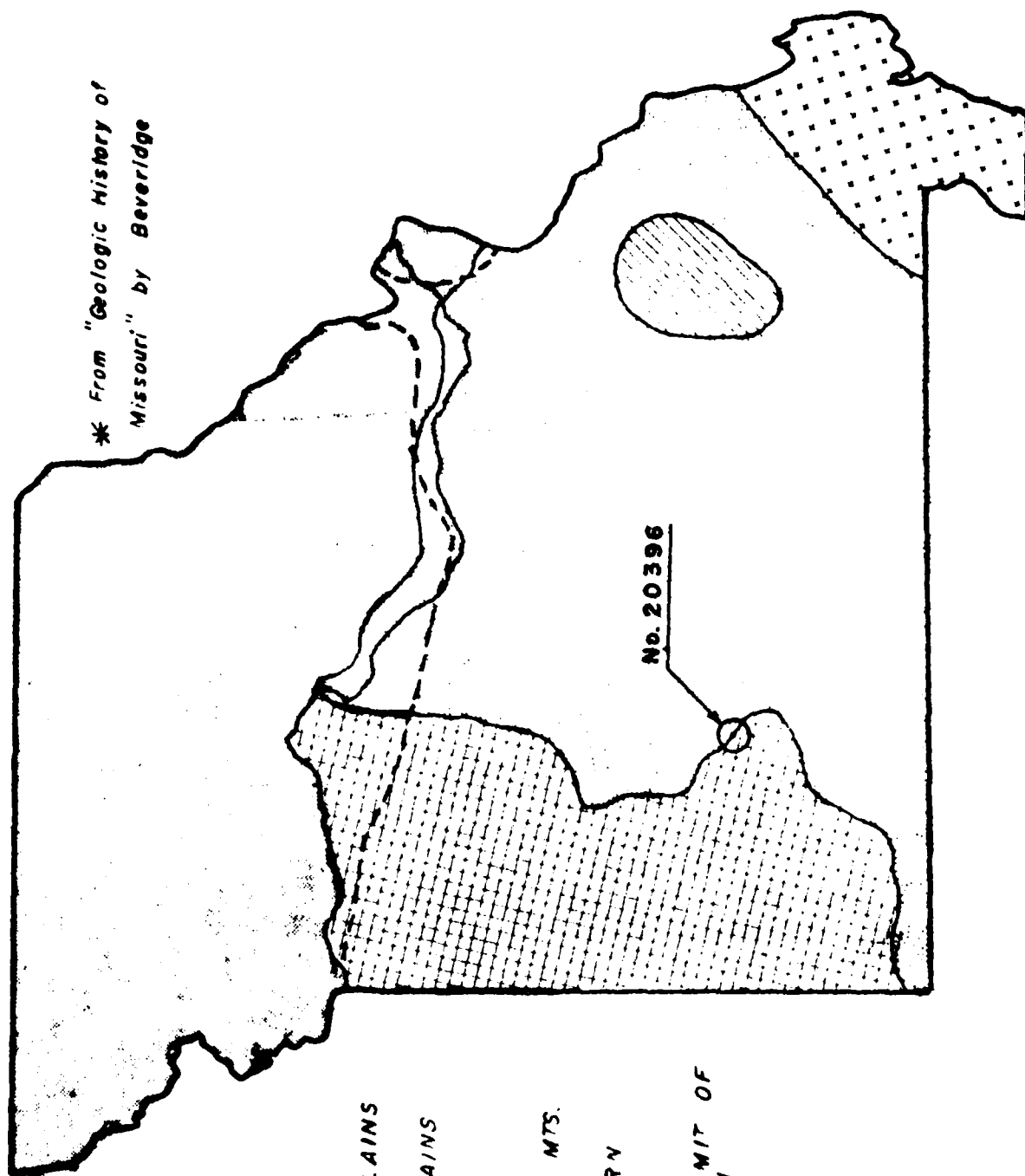
It is anticipated that the lake level may be lowered by continued erosion. However, the lowering of the lake level will be gradual and will not release a catastrophic flood of water. The spillway erosion does not threaten the integrity of embankment fill. The spillway erosion does not present a threat to the safety of the public downstream from the dam.


David Hoffman
Geologist, P. E.
Dam Inventory Program
Engineering Geology
Geology and Land Survey

Sheet 13 of Appendix A

APPENDIX B

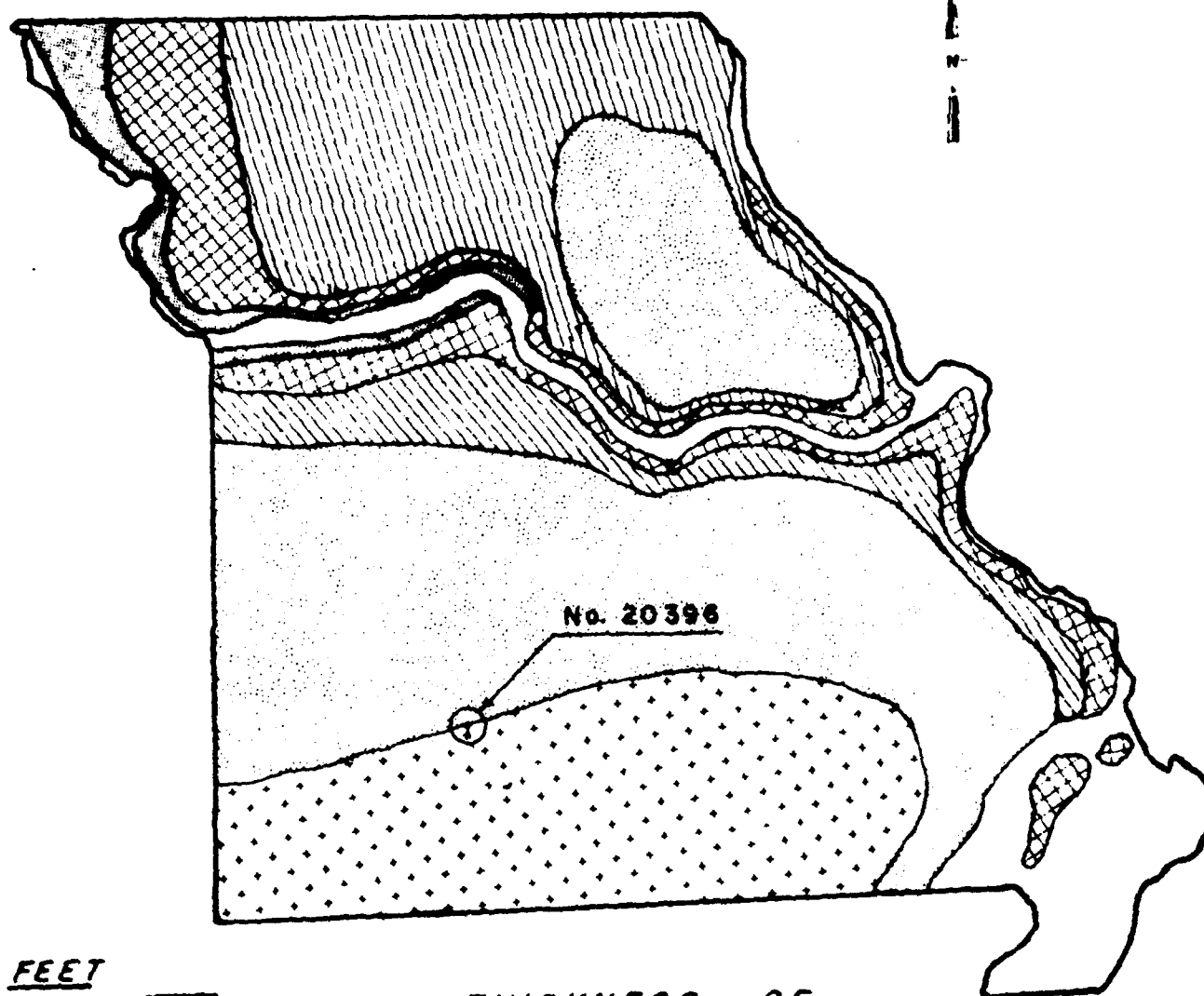
MAJOR GEOLOGIC REGIONS OF MISSOURI








* From "Geologic History of Missouri" by Beveridge

- GLACIATED PLAINS
- WESTERN PLAINS
- OZARKS
- ST. FRANCOIS MTS.
- SCUTHEASTERN LOWLANDS
- SOUTHERN LIMIT OF GLACIATION

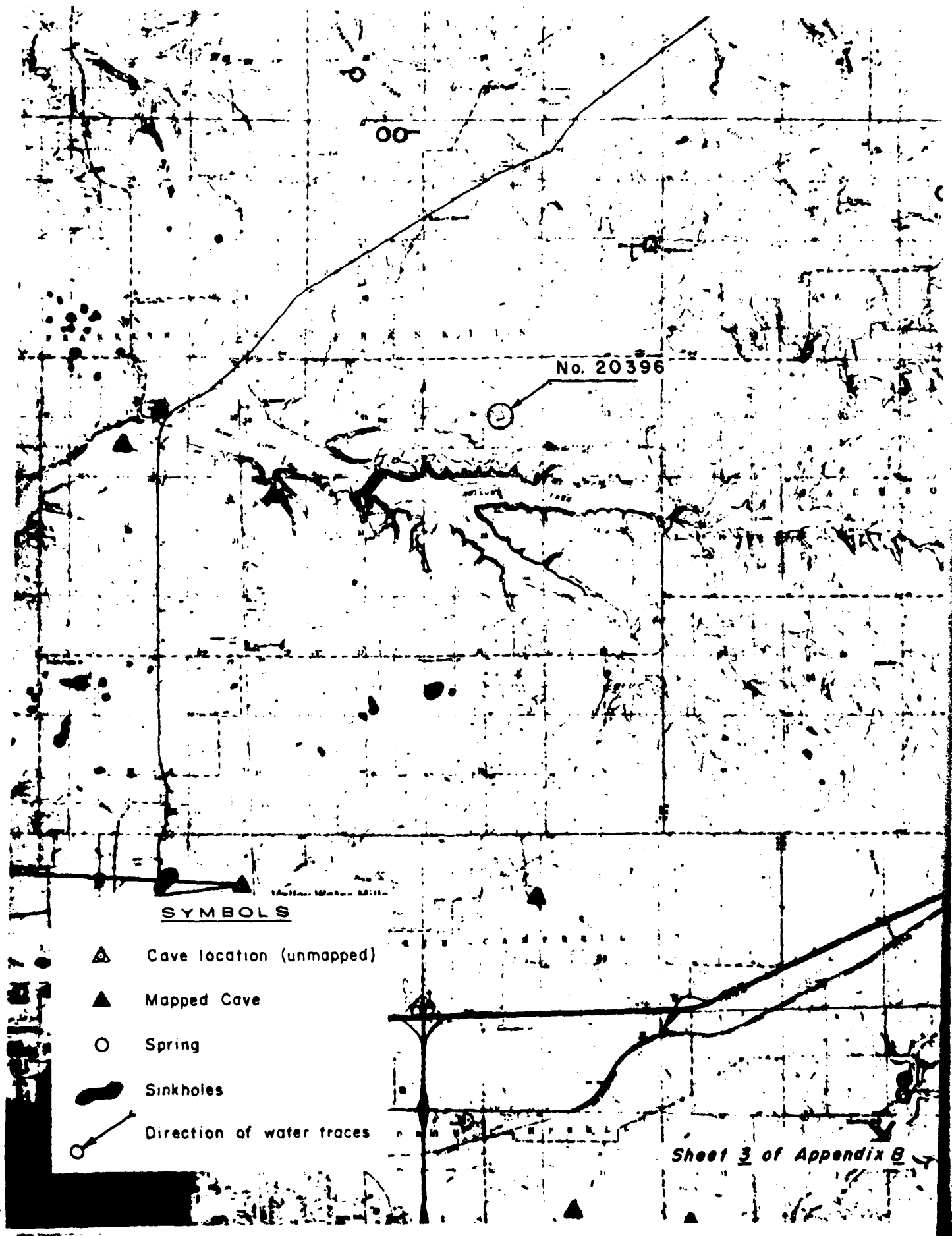
* From "Soils of Missouri"



<u>FEET</u>	
20+	
10-20	
5-10	
2.5-5	
2.5-	

THICKNESS OF
LOESSIAL DEPOSITS

SHEET 2 OF APPENDIX B

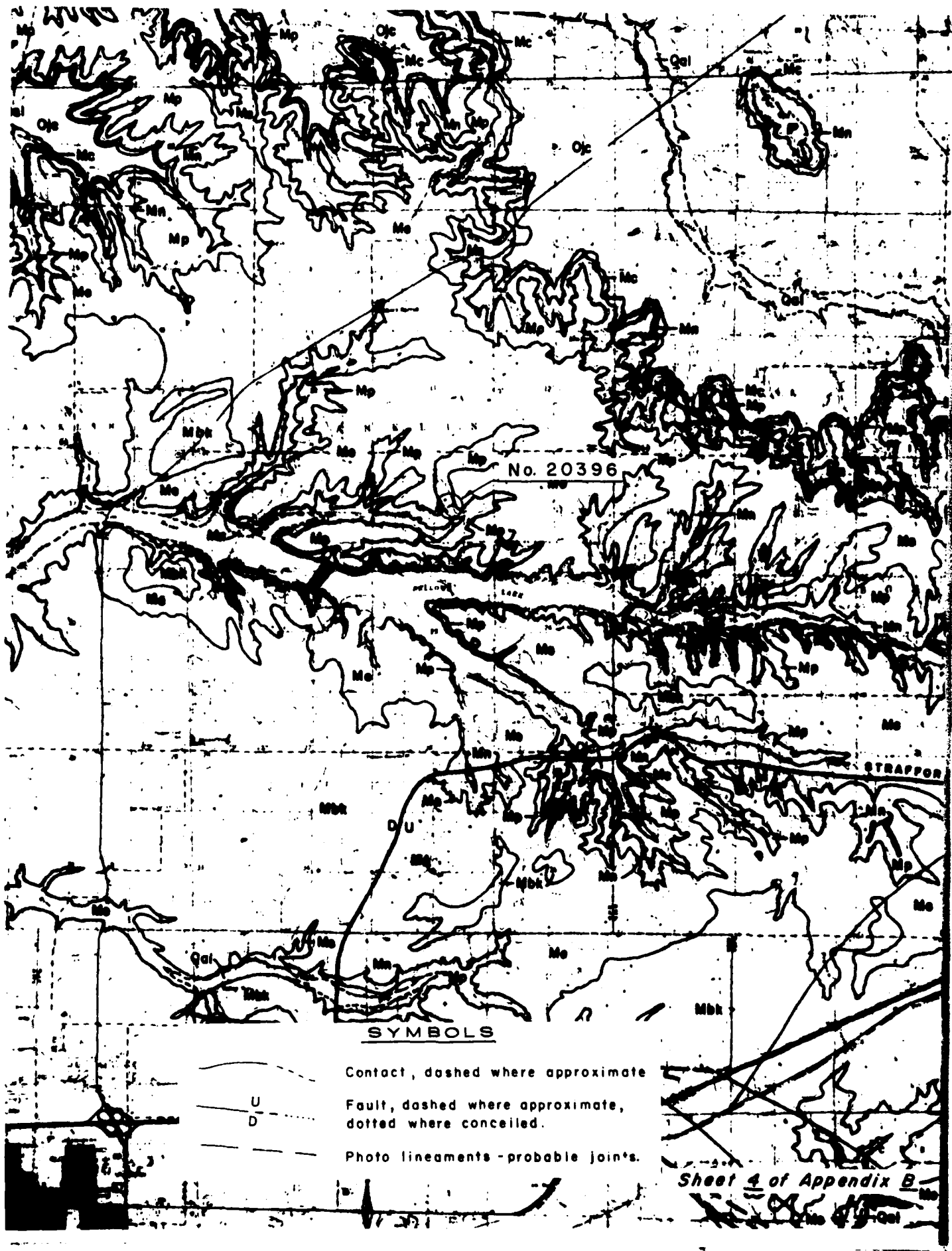


No. 20396

SYMBOLS

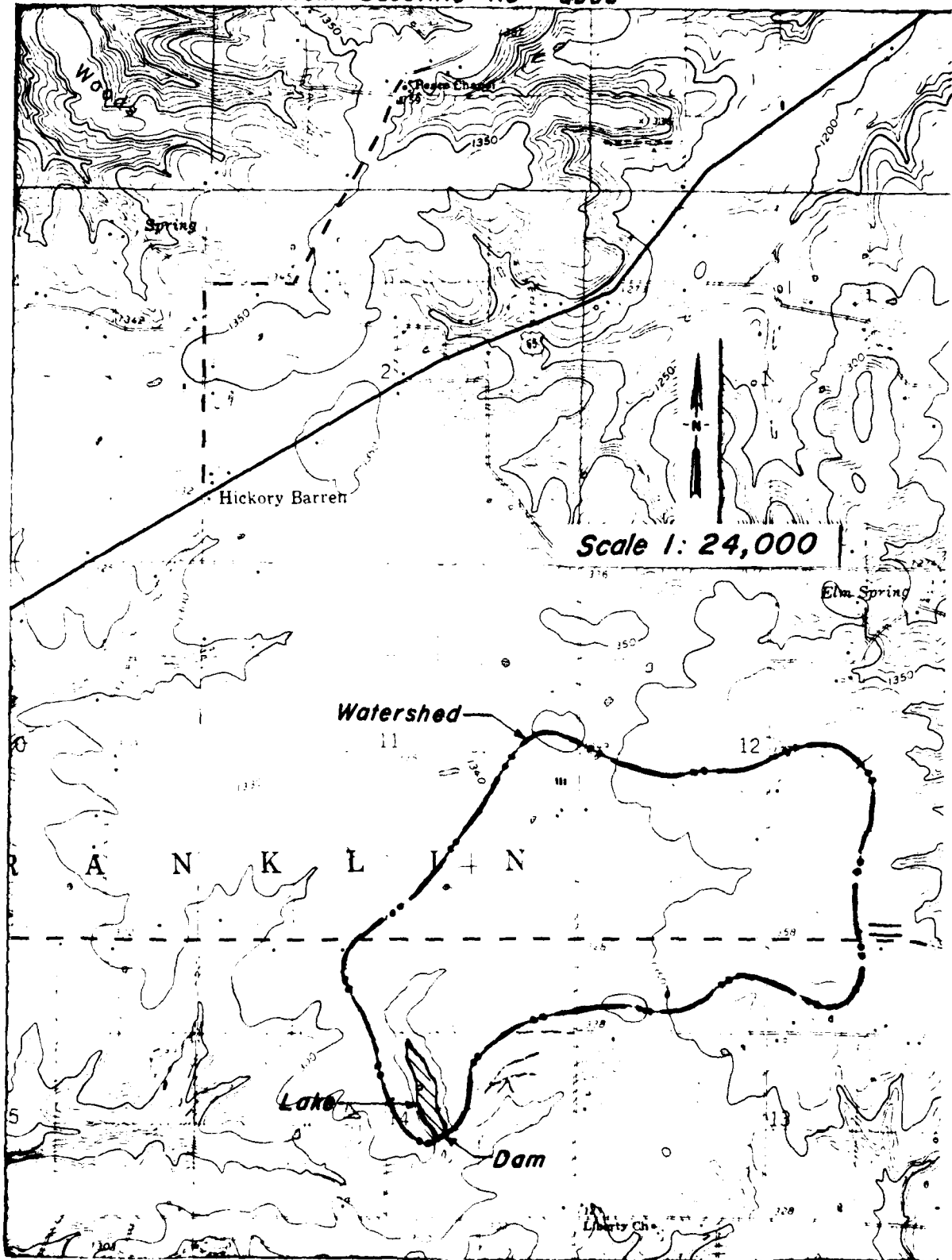
- △ Cave location (unmapped)
- ▲ Mapped Cave
- Spring
- Sinkholes
- Direction of water traces

Sheet 3 of Appendix B



APPENDIX C

From Bassville 7.5' Quad



LAKE AND WATERSHED MAP

Sheet 1 Appendix C

HYDRAULICS AND HYDROLOGIC DATA

Design Data: From Field Measurements and Computations

Experience Data: No records are available. The emergency spillway has been used and the crest of the spillway has been lowered and eroded to within a few inches of the crest of the primary drop inlet structure. The dam has not been overtopped. High water marks were found at elevation 51.5 on the day of inspection.

Visual Inspection: At the time of inspection, the pool level was 0.15 feet above normal pool.

Overtopping Potential: Flood routing studies were performed to determine the overtopping potential of the dam. The watershed and the reservoir surface areas were obtained by planimeter from the U.S.G.S. 7.5 minute, Bassville, Missouri quadrangle map. The storage volume was developed from this data. A 5 minute interval unit graph for the PMF was developed for this watershed, which resulted in a peak inflow of 790 c.f.s. and a time to peak of 30 minutes. Application of the probable maximum precipitation minus losses results in a flood hydrograph peak inflow of 6520 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411.

Based on our analyses, the spillway will pass 31 percent of the Probable Maximum Flood (PMF) at the present emergency spillway elevation. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that the structure (small size with high downstream hazard potential) pass 50 to 100 percent of the PMF, without overtopping. Considering that the dam is only 23 feet high and has a storage capacity at top of dam of 102 acre-feet, 50 percent of the PMF has been determined to be the appropriate spillway design flood.

The routing of the 50 percent of the PMF through the spillways and dams indicates that the dam will be overtopped by 0.89 feet at elevation 56.99. The duration of the overtopping will be 0.92 hours, and the maximum outflow will be 3136 c.f.s. The maximum discharge capacity of the combined spillways is 1501 c.f.s. Analysis of the data indicates that the 100-year frequency flood will not overtop the dam.

The routing of the PMF was also studied considering the original design condition. The computer input and output for the PMF and the hydrograph for 50 percent of the PMF are presented in this Appendix C.

Sheet 2 Appendix C

OVERTOPPING ANALYSIS FOR MO # 20396

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.
Hydraulic Inputs Are as Follows:

- a. Twenty-four Hour Rainfall of 26.7 Inches for 200 Square Miles - All Season Envelope
- b. Drainage Area = 560 Acres; = 0.8 Square Miles
- c. Travel Time of Runoff 0.75 Hrs.; Lag Time 0.45 Hrs.
- d. Soil Conservation Service Soil Group D
- e. Soil Conservation Service Runoff Curve No. 91 (AMC) III
- f. Proportion of Drainage Basin Impervious 0.03

2. Spillways

- a. Primary Spillway: Drop Inlet 36" CMP riser, C = 3.10 24" CMP conduit
- b. Emergency Spillway: Earth Channel
Length 22 ft.; Side Slopes 3.4:1; C = 2.65
1.6:1
- c. Dam Overflow
Length 450 ft.; Crest El. 56.1; C = 3.0

3. Spillway and Dam Rating:

Curve prepared by Hanson Engineers. Data provided to computer on Y4 and Y5 cards. Based on the following:

Primary Spillway - Weir Flow $Q = CLH^{1.5}$

Pipe Flow: U.S. Bureau of Public Roads. Chart 288-D-2910

Emergency Spillway & Dam Overflow $Q = CLH^{1.5}$

Note: Time of Concentration from Equation $T_c = \frac{(11.9 L^3)^{.385}}{H}$

California Culvert Practice, California Highways and
Public Works, Sept. 1942.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph
 - a. Peak - 790 c.f.s.
 - b. Time to Peak 30 Min.
2. Flood Routings Were Computed by the Modified Puls Method
 - a. Peak Inflow
50% PMF 3260 c.f.s.; 100% PMF 6520 c.f.s.
 - b. Peak Elevation
50% PMF 56.99; 100% PMF 58.11
 - c. Portion of PMF That Will Reach Top of Dam
31% ; Top of Dam Elev. 56.10 Ft.

AREA IN SQUARE MILES (SQUARE KILOMETERS)

94}{ 41.89}{ 07.74}{ 00.00}{ 10.00}

SUMMARY OF DAN SAFETY ANALYSIS

SHEET 6 APPENDIX C

Discharge (c.f.s.)

3600

3200

2800

2400

2000

1600

1200

800

400

12.05145.
12.10146.
12.15147.
12.20148.
12.25149.
12.30150.
12.35151.
12.40152.
12.45153.
12.50154.
12.55155.
13.00156.
13.05157.
13.10158.
13.15159.
13.20160.
13.25161.
13.30162.
13.35163.
13.40164.
13.45165.
13.50166.
13.55167.
14.00168.
14.05169.
14.10170.
14.15171.
14.20172.
14.25173.
14.30174.
14.35175.
14.40176.
14.45177.
14.50178.
14.55179.
15.00180.
15.05181.
15.10182.
15.15183.
15.20184.
15.25185.

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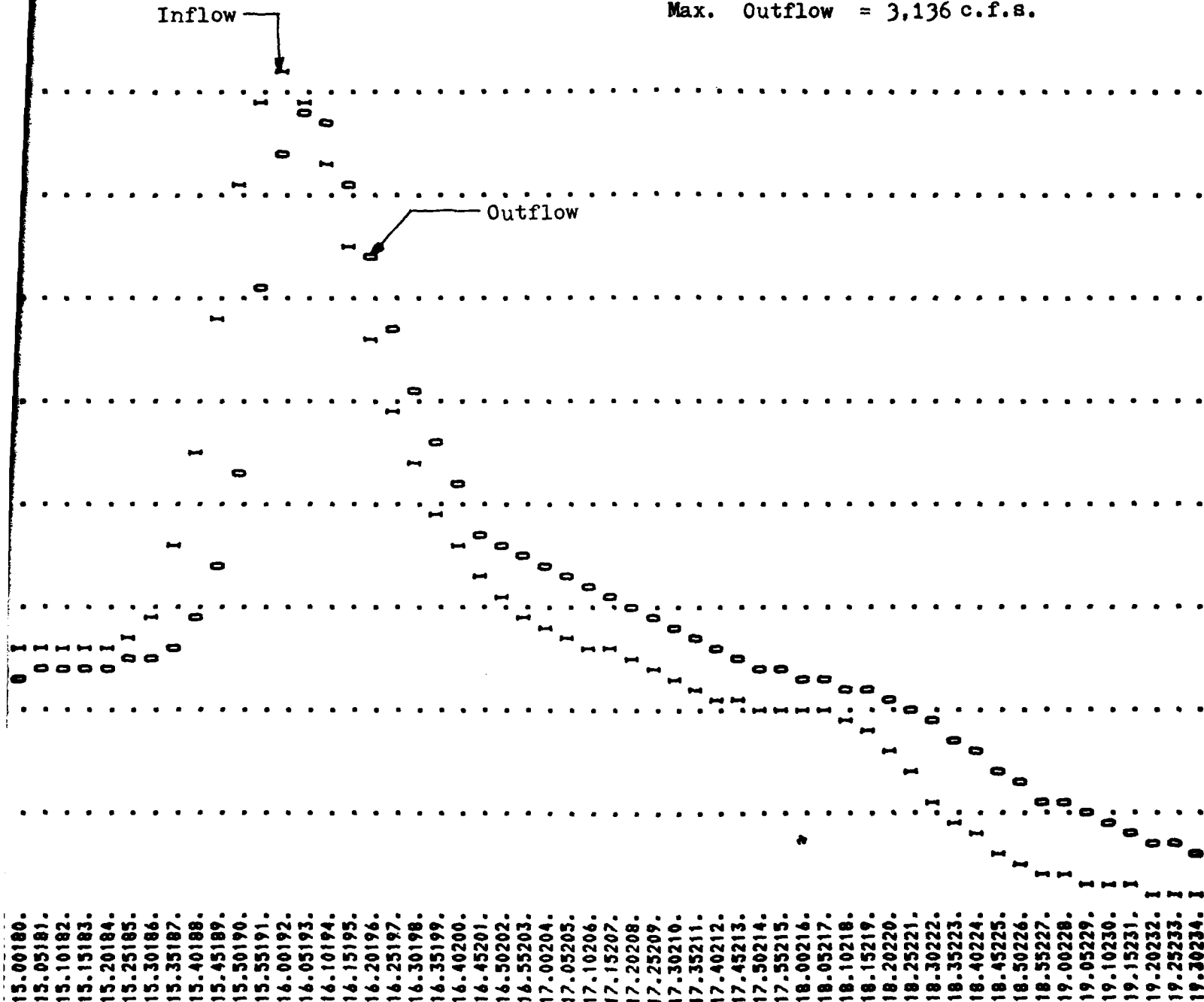
INFLOW - OUTFLOW
HYDROGRAPH
FOR 50% P. M. F.

Max. Inflow = 3,260 c.f.s.

Max. Outflow = 3,136 c.f.s.

Inflow

Outflow



Time (hrs.)

SHEET 7 APPENDIX C

1

SHEET 8 APPENDIX C

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS						
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7
				0.10	0.15	0.20	0.30	0.40	0.50	1.00
HYDROGRAPH AT	1	0.80	1	652.	978.	1304.	1956.	2608.	3260.	6520.
	(	2.07)	(	18.46)	(	27.70)	(	36.93)	(	55.39)
ROUTED TO	2	0.80	1	426.	659.	926.	1793.	2514.	3178.	6404.
	(	2.07)	(	12.07)	(	18.67)	(	26.21)	(	50.76)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1			INITIAL VALUE		SPILLWAY CREST		TOP OF DAM	
			ELEVATION					
			STORAGE		49.52		56.10	
			OUTFLOW		34.		102.	
					0.		1462.	

RATIO OF PMF	MAXIMUM RESERVOIR U.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	54.00	0.00	75.	426.	0.00	16.33	0.00
0.15	55.02	0.00	88.	659.	0.00	16.33	0.00
0.20	55.81	0.00	98.	926.	0.00	16.33	0.00
0.30	56.60	0.50	109.	1793.	0.67	16.17	0.00
0.40	56.95	0.85	115.	2514.	1.17	16.08	0.00
0.50	57.23	1.13	119.	3178.	1.75	16.08	0.00
1.00	58.30	2.20	136.	6404.	5.33	16.08	0.00

OUTPUT DATA

(DESIGN CONDITION)

SHEET 9 APPENDIX C

DESIGN SHEET FOR CLASS II, III, IV * DETENTION STORAGE STRUCTURE
WITH DROP INLET SPILLWAY -- HOOD INLET SPILLWAY -- CANOPY INLET SPILLWAY *

Landowner E. H. Green County St. Louis

Design by Chas. D. H. H. Date 9-26-74 Checked by _____ Date _____

Drainage area = 530 ac. Height x storage = _____ x _____ = _____

WATERSHED CONDITIONS AND FACTORS

Location factor: $L = \underline{1.1}$
Infiltration factor: (above) (average) (below) * $I = \underline{.1}$
Topographic factor: 1 % average slope $T = \underline{1.6}$
Shape factor: runoff distance = 1000 ft. $S = \underline{.9}$
Cover factor: cropland _____ %, pasture 100 %, timber _____ % $V = \underline{.1}$
Contouring factor: $C = \underline{1}$
Storage factor: _____ % terraced $P = \underline{1}$

PEAK RATE OF RUNOFF AND VOLUME OF RUNOFF

Product of factors = $L \times I \times T \times S \times V \times C \times P = \underline{.237}$ $Q_{10} = \underline{350}$ c.f.s.

$V \times I = \underline{.7} \times \underline{.1} = \underline{.65}$

For Principal Spillway Design:

2-year peak rate of runoff = $Q_{ip} = \underline{.5} \times \underline{350}$ c.f.s. = 175 c.f.s.

Rate of volume of runoff = 104 ac. ft./ac. (Table 1, 1519)

Total volume of runoff = $V_{rp} = (\text{drainage area}) \times (\text{rate of volume of runoff}) \times L =$
530 ac. x 104 ac. ft./ac. x 1.1 = 23.32 ac. ft.

For Both Spillways (Total Structure):

.25-year peak rate of runoff = $Q_i = \underline{1.3} \times \underline{350}$ c.f.s. = 455 c.f.s.

Rate of volume of runoff = 1.2 ac. ft./ac.

Total volume of runoff = $V_r = \underline{530}$ ac. x 1.2 ac. ft./ac. x 1.1 = 69.9 ac. ft.

*Mark out those items that do not apply.

Instructions for use of form: Make one pencil copy for applicable structure. File with other worksheets and structure plan in landowner's folder in field office.

Sheet D of Appendix C

117 13.77

Conduit:

Minimum entrance head = 1.7 ft. (1510 or 1511)

Type 105 Height = ft. Diameter = 36 in. (1511)

21

Exit Section:

Use width of 2.5 ft.

S.L-32, 175-2(2)

APPENDIX D

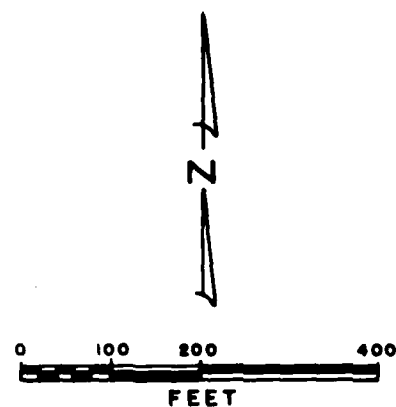
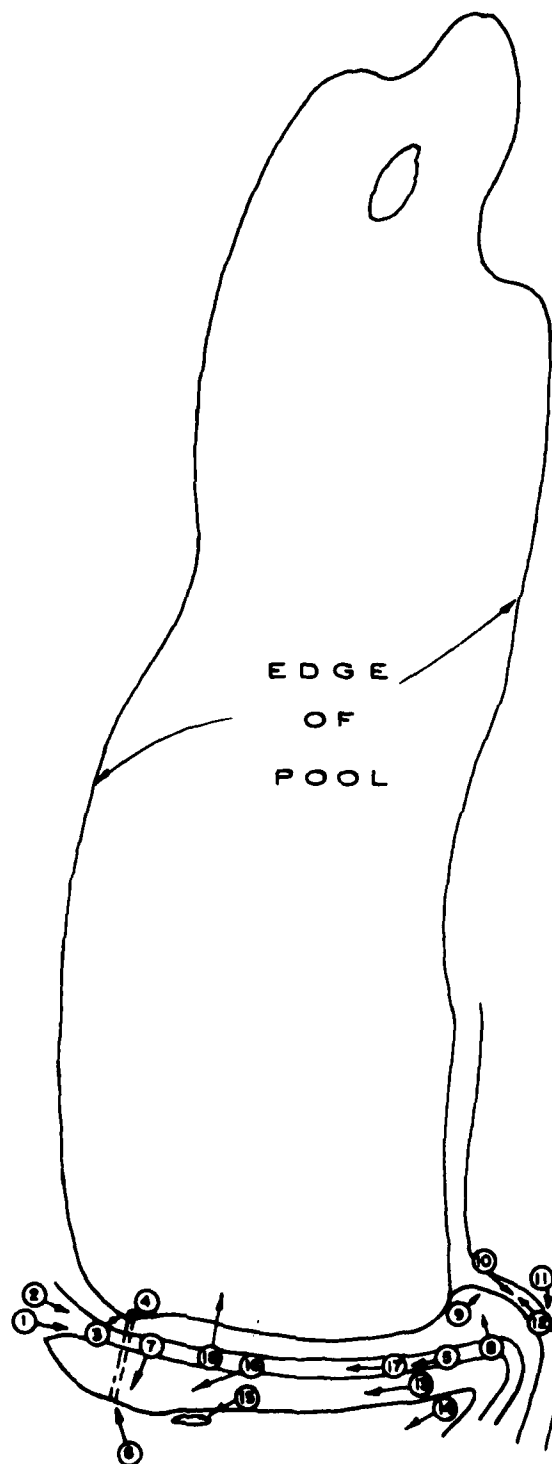
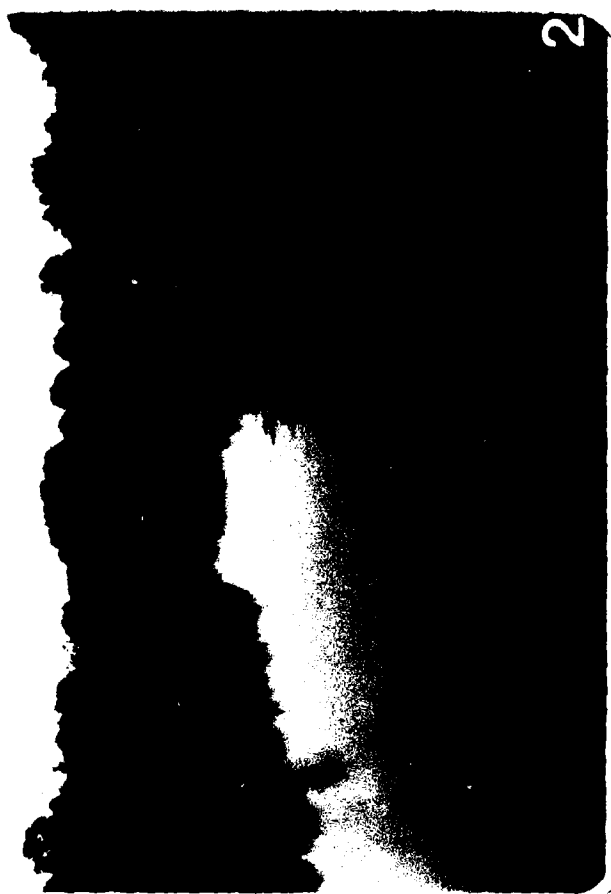
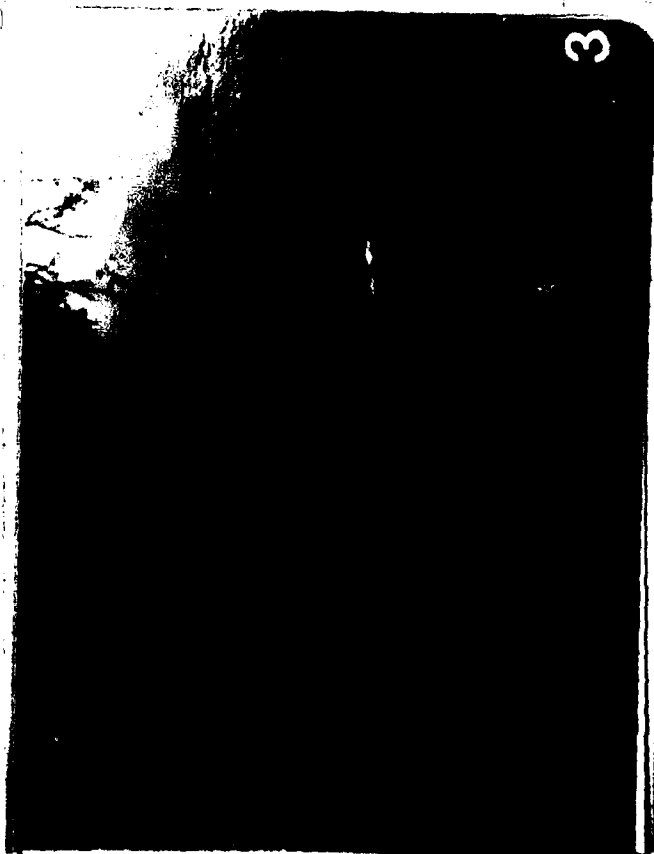


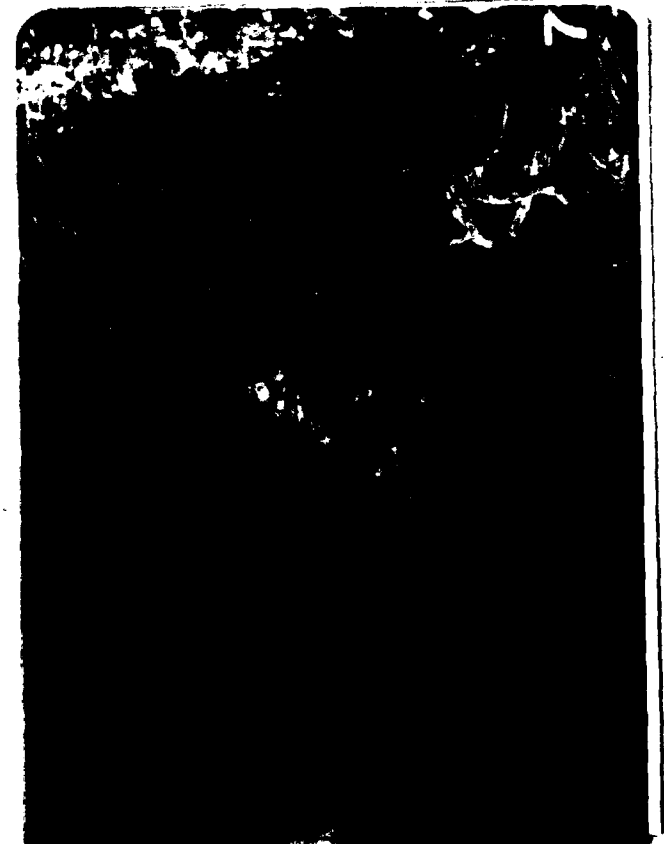
PHOTO INDEX
D & R PIPELINE CONSTRUCTION COMPANY LAKE
GREENE COUNTY, MO.

LIST OF PHOTOGRAPHS

Photo No.

1. Crest of Dam
2. Upstream Face of Dam
3. Primary Spillway (36 Inch CMP)
4. Overflow of Primary Spillway
5. Upstream Face of Dam
6. Primary Spillway Outlet
7. Downstream Channel
8. Emergency Spillway (Note Erosion)
9. Emergency Spillway
10. Emergency Spillway
11. Emergency Spillway
12. Emergency Spillway
13. Crest of Dam
14. Downstream Face, East Side
15. West Area of Toe
16. Downstream Face, West Side
17. Upstream Berm (Note High Water Mark)
18. Lake and Reservoir Areas
19. Aerial Looking Southwest
20. Aerial Looking Northwest
21. Aerial of Embankment
22. Aerial Looking West
23. Aerial of Emergency Spillway
24. Aerial Looking Southeast

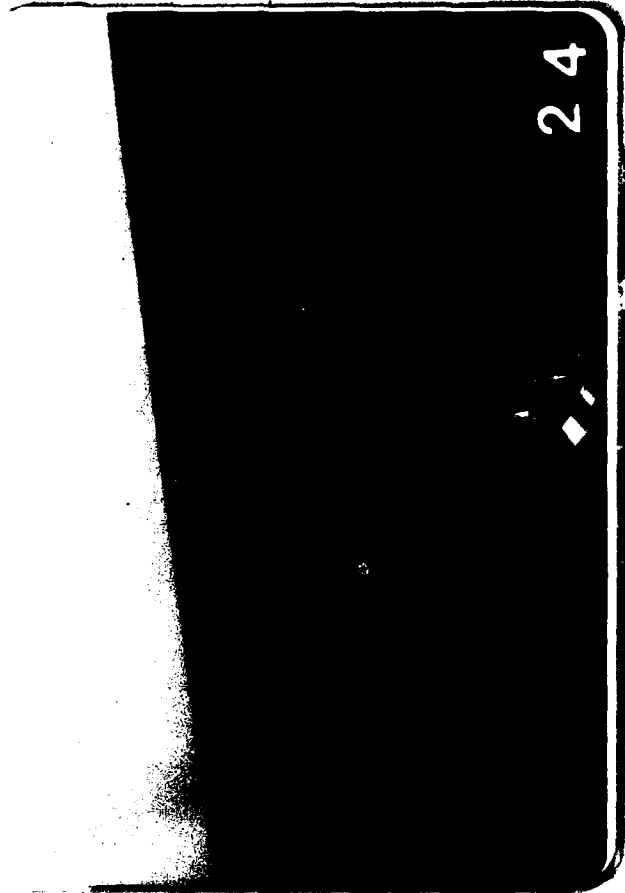




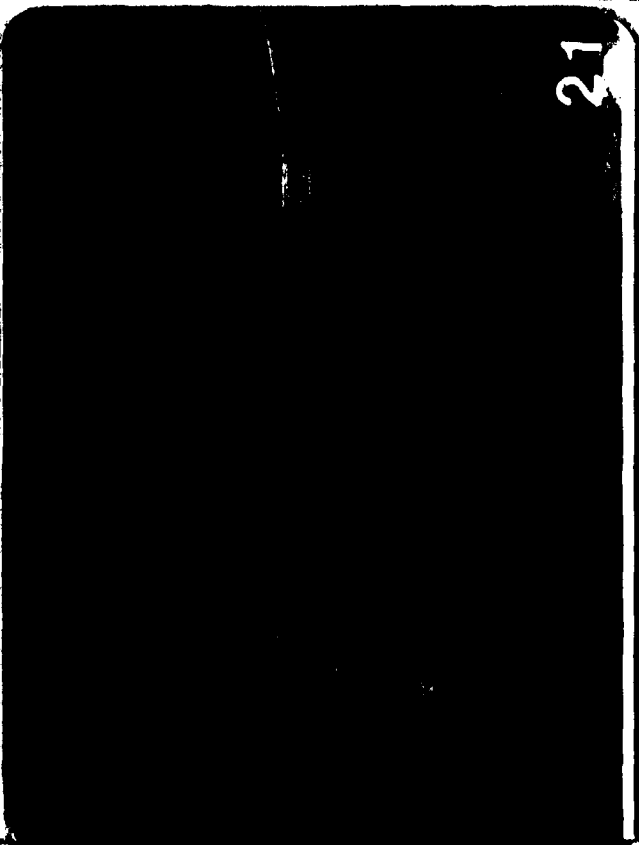




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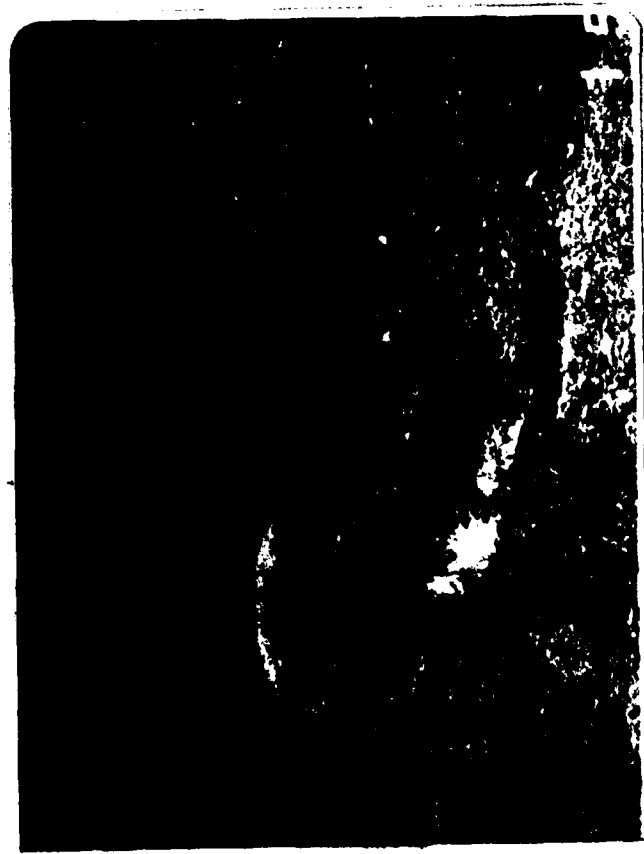
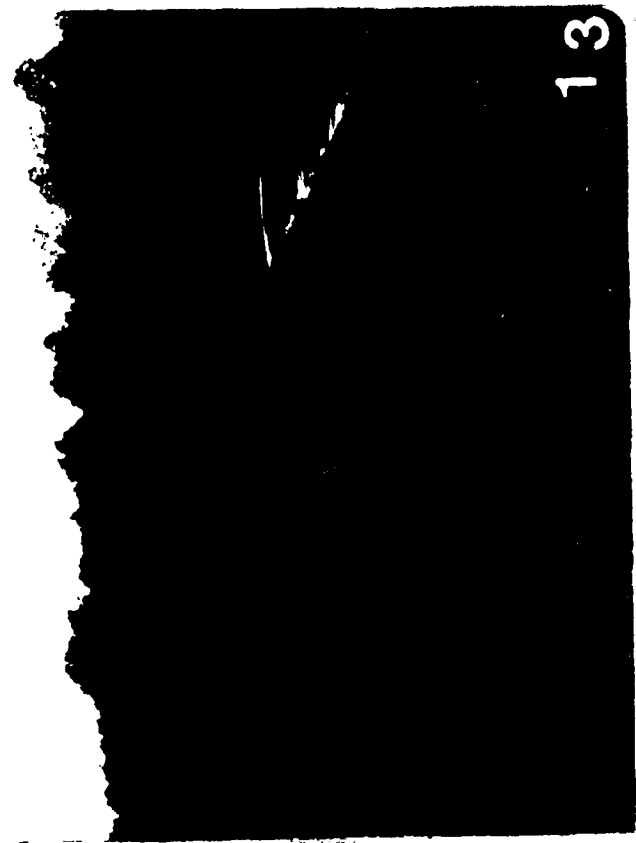


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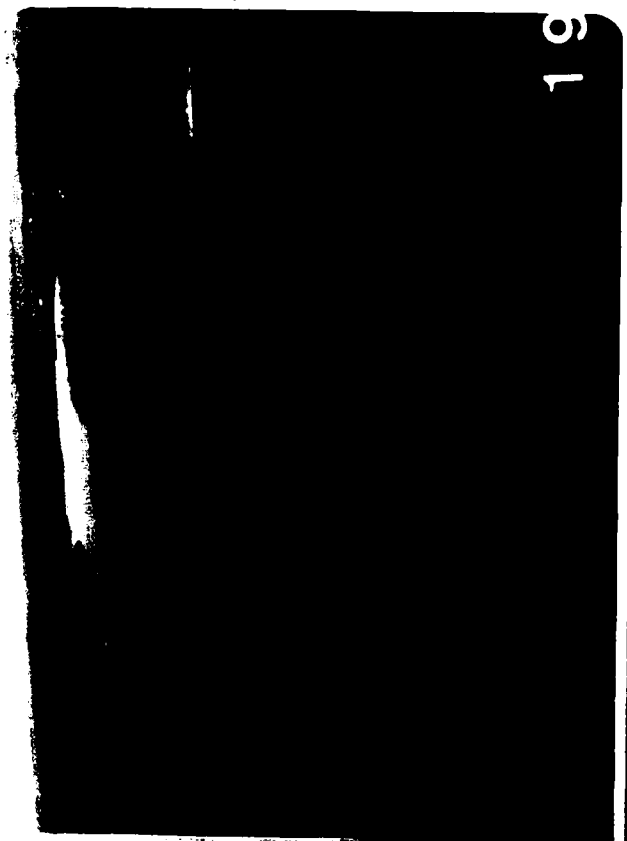




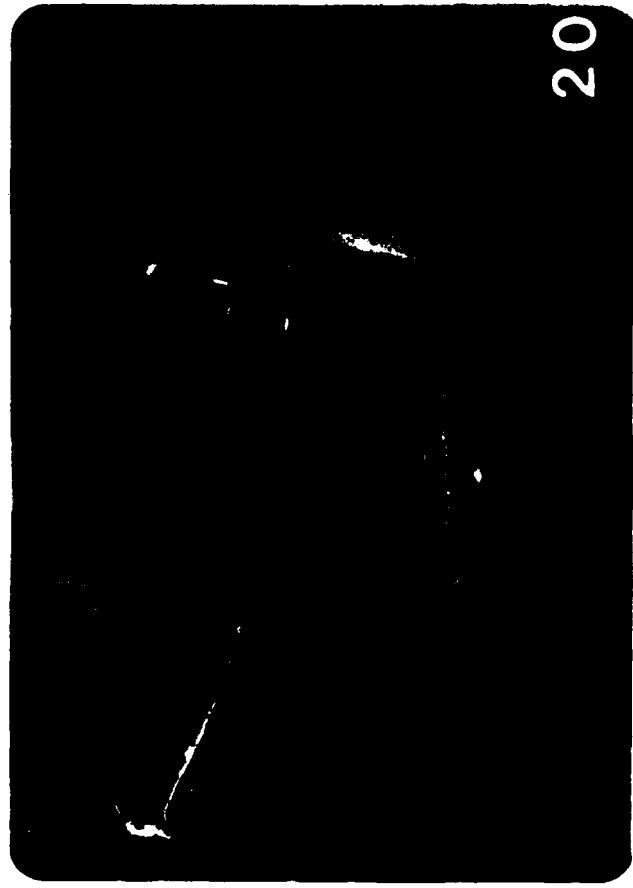
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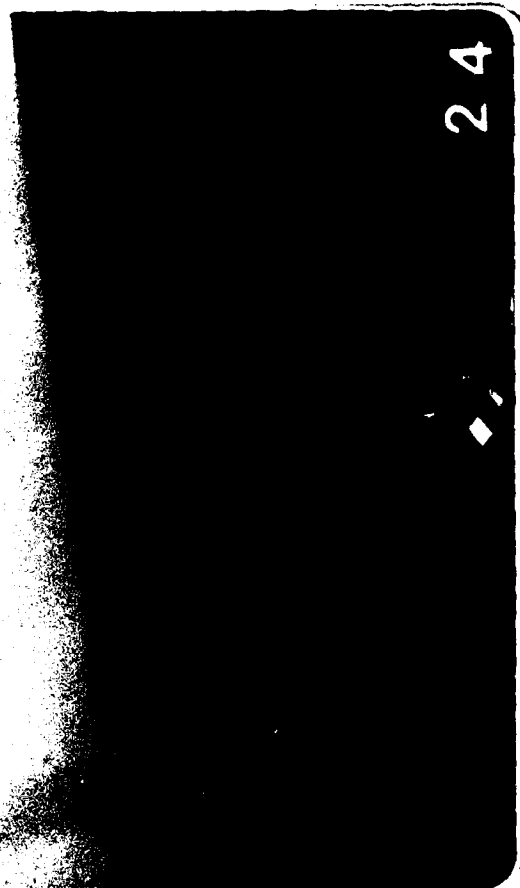
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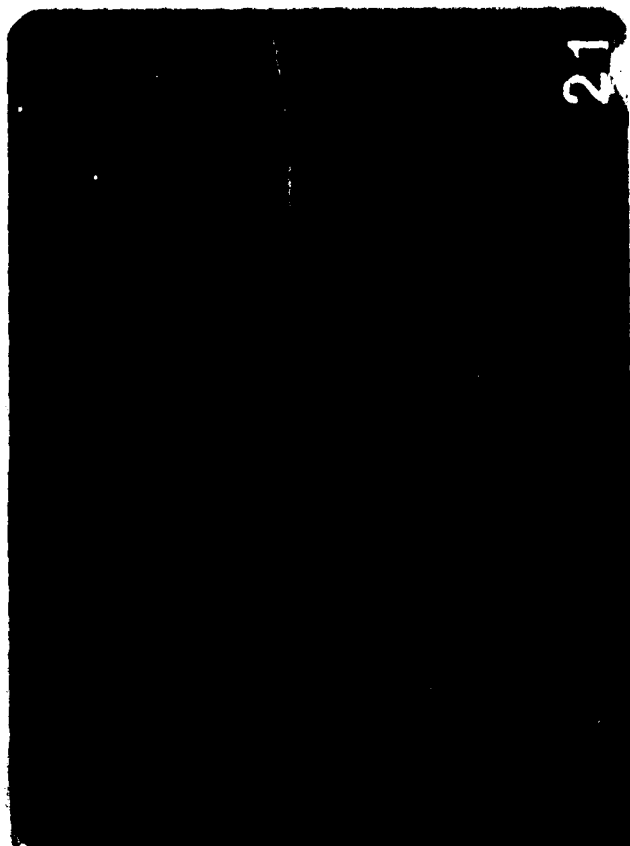
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